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(54) **LEAN-COMPENSATING MOTORCYCLE WITH CHANNEL WHEELS**

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B60G 99/00 (2010.01)

(52) **U.S. Cl.**
CPC ***B62K 11/00*** (2013.01); ***B60G 99/002*** (2013.01); *B60G 2300/12* (2013.01); *B60G 2300/45* (2013.01)

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USPC 280/755, 124.103, 6.15, 6.16, 6.154; 180/41, 219, 282
See application file for complete search history.

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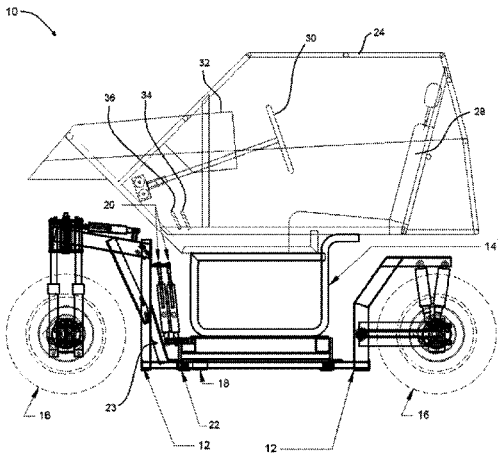
(57) **ABSTRACT**

A lean-compensating motorcycle for balancing a user includes a lower frame with wide wheels and an upper frame supporting a rider. The lower and upper frames pivot on an axis substantially parallel to the motorcycle's line of travel, and a pivot drive governs pivoting movement. The pivot drive is controlled by a level-sensing control system that adjusts the pivot drive to maintain the upper frame upright by applying force against the lower frame, the lower frame counterbalancing the pivoting motion against the wide wheels. The wheels ideally include a central channel sized to accommodate raised pavement markers, such as dots and reflectors, to provide for smooth travel. The upper frame includes a housing in which the user sits, in a manner similar to a conventional automobile since propping the motorcycle up with the user's legs is largely unnecessary.

17 Claims, 11 Drawing Sheets



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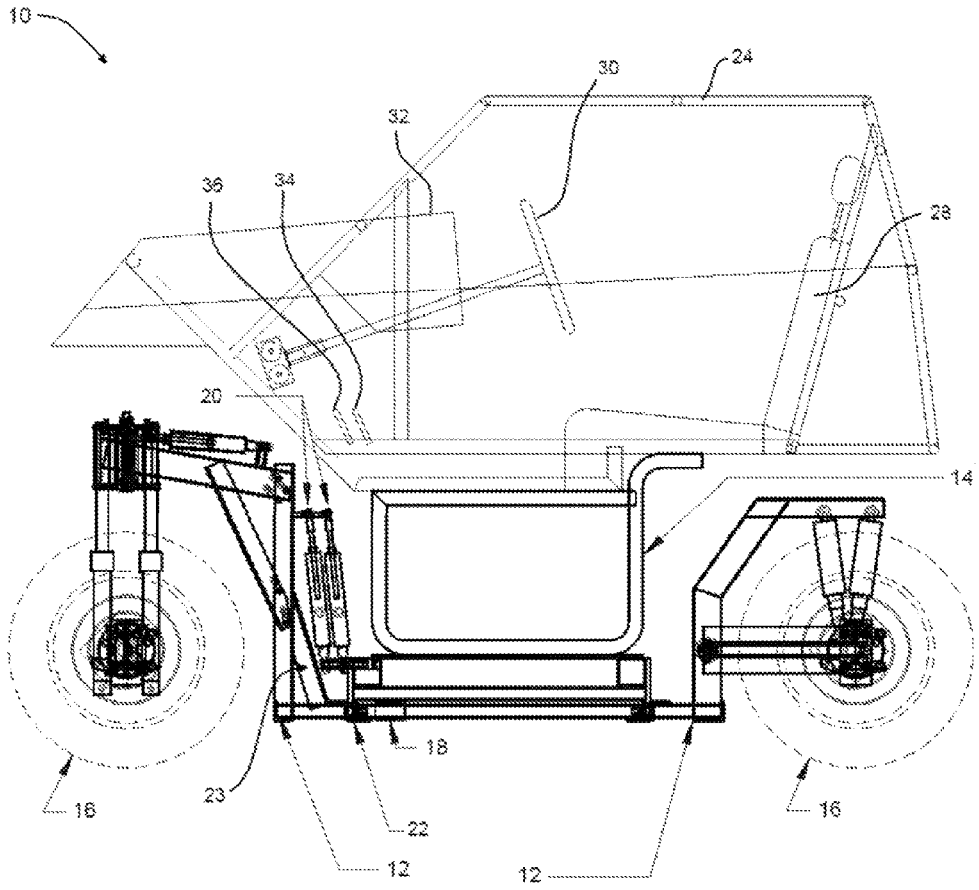

FIGURE 1

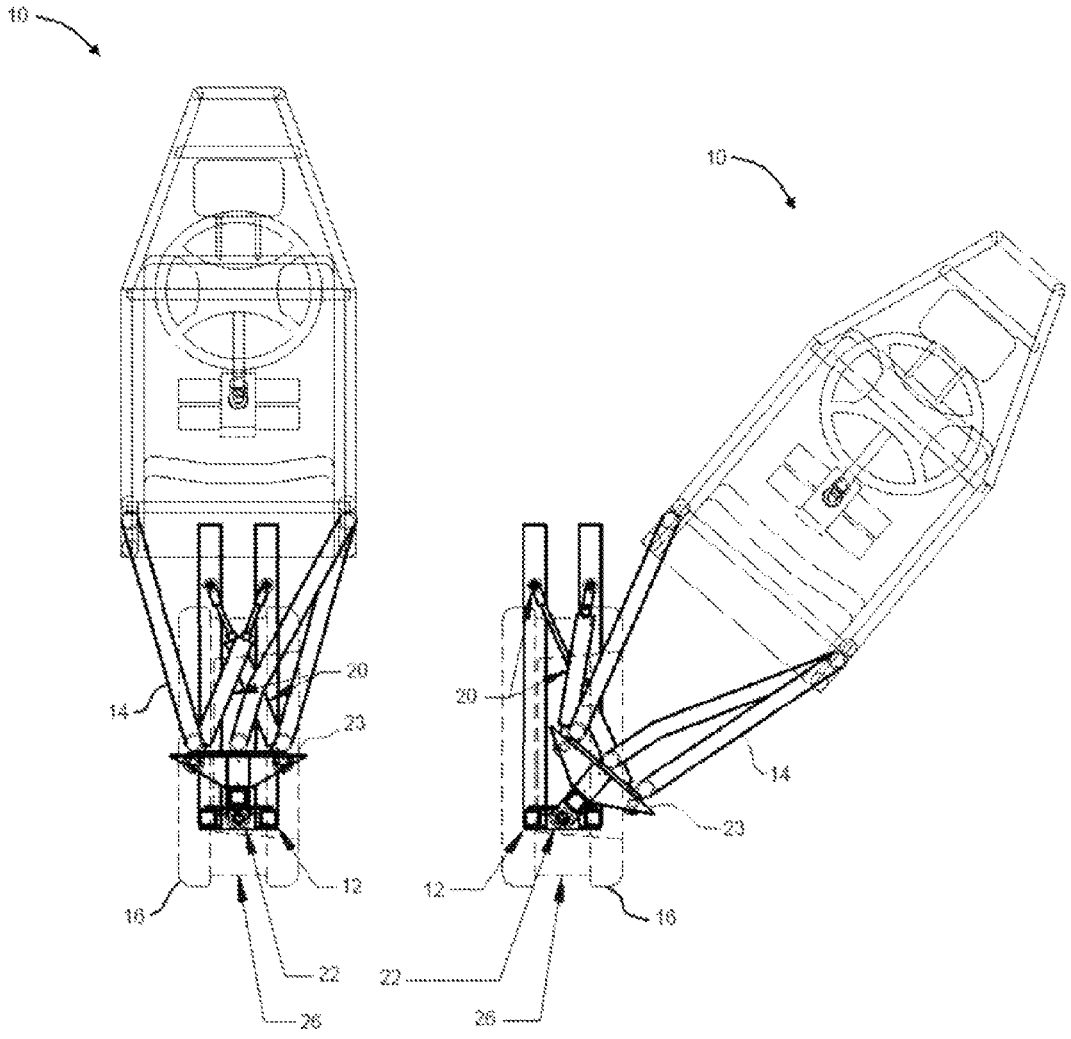

FIGURE 2A *FIGURE 2B*

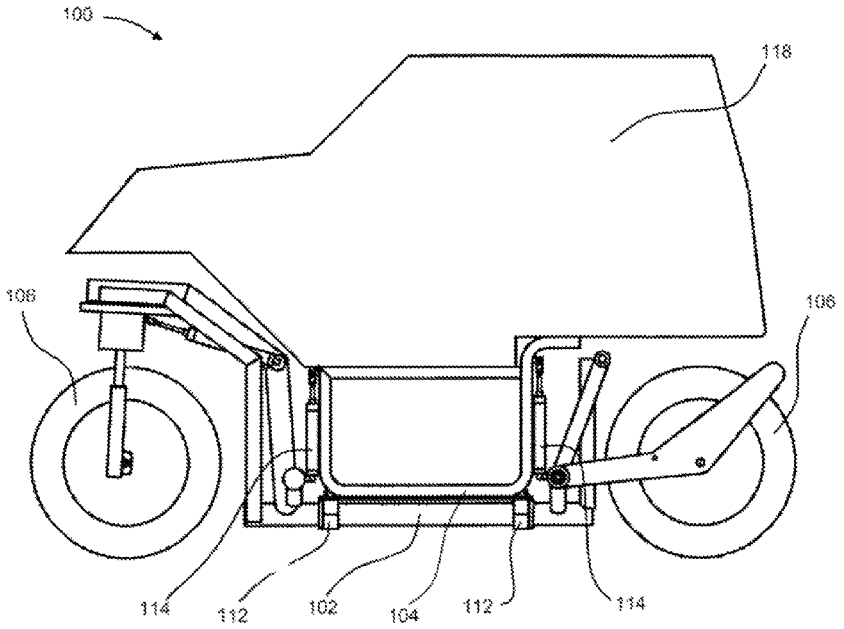

FIGURE 3

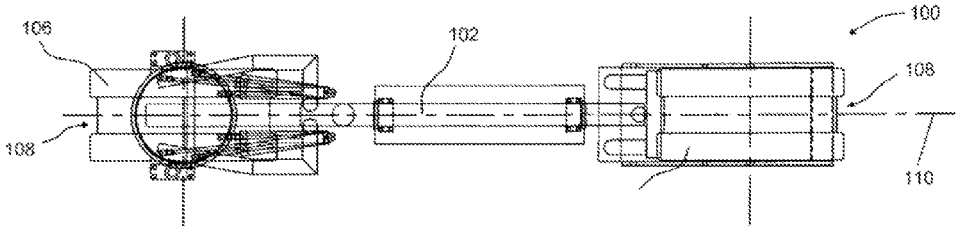

FIGURE 4

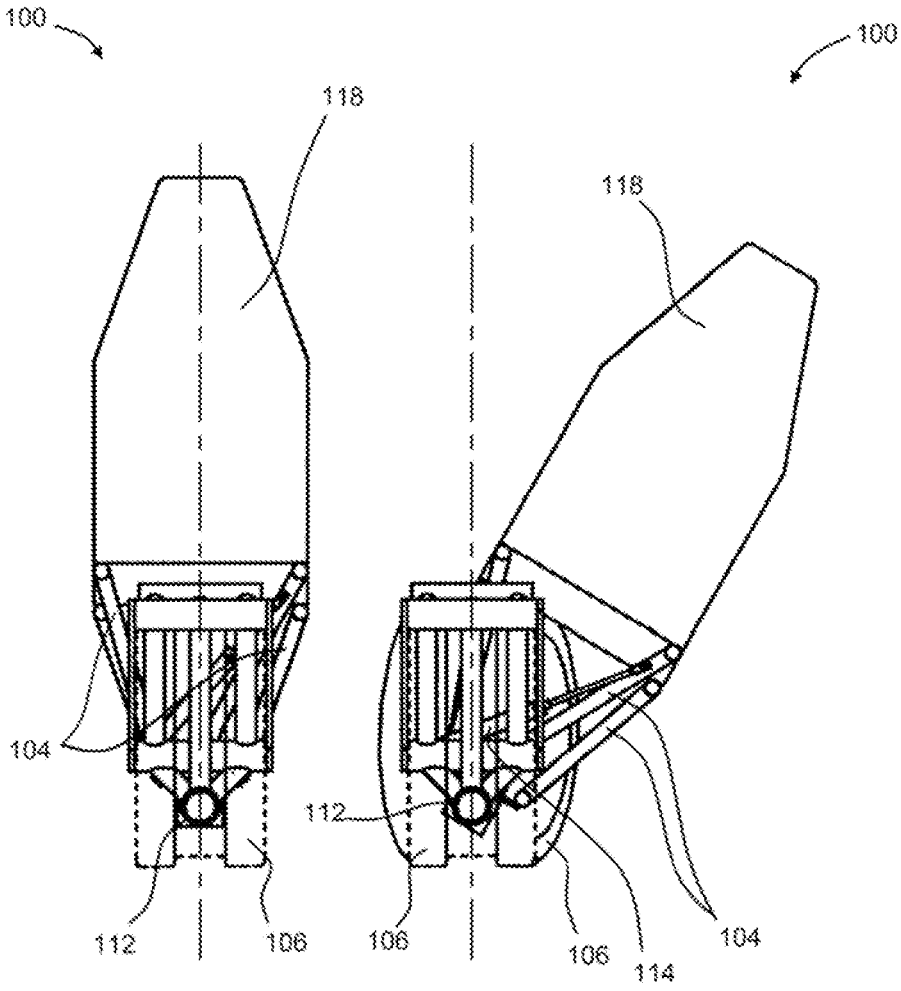

FIGURE 5A *FIGURE 5B*

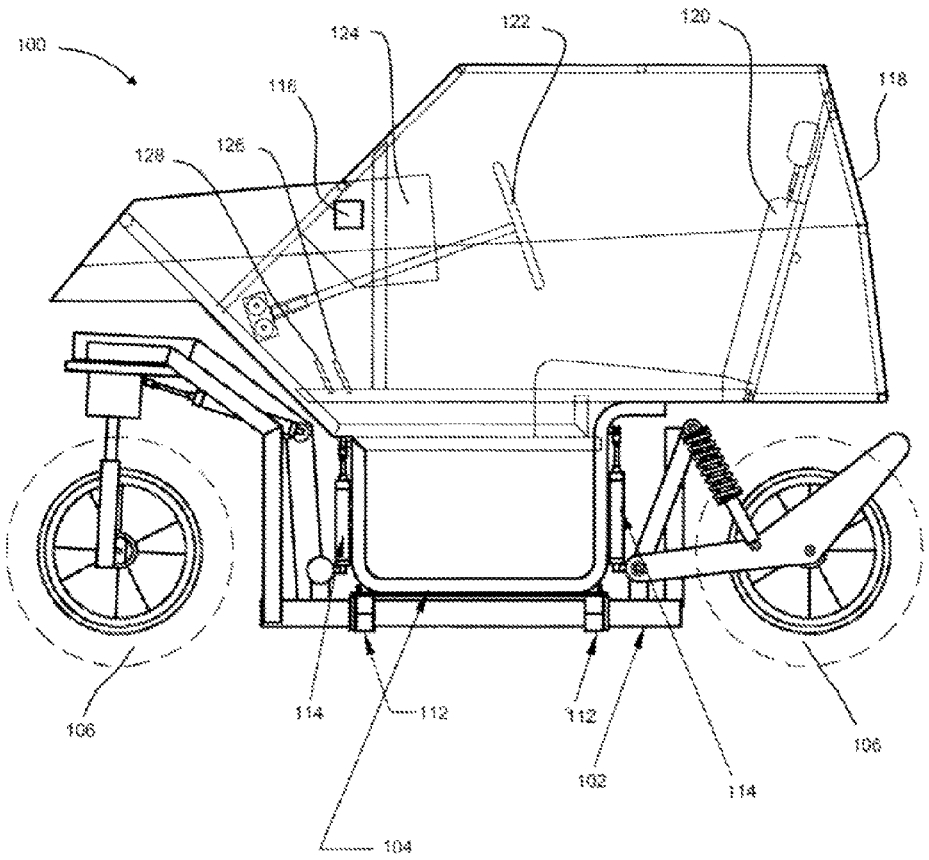

FIGURE 6

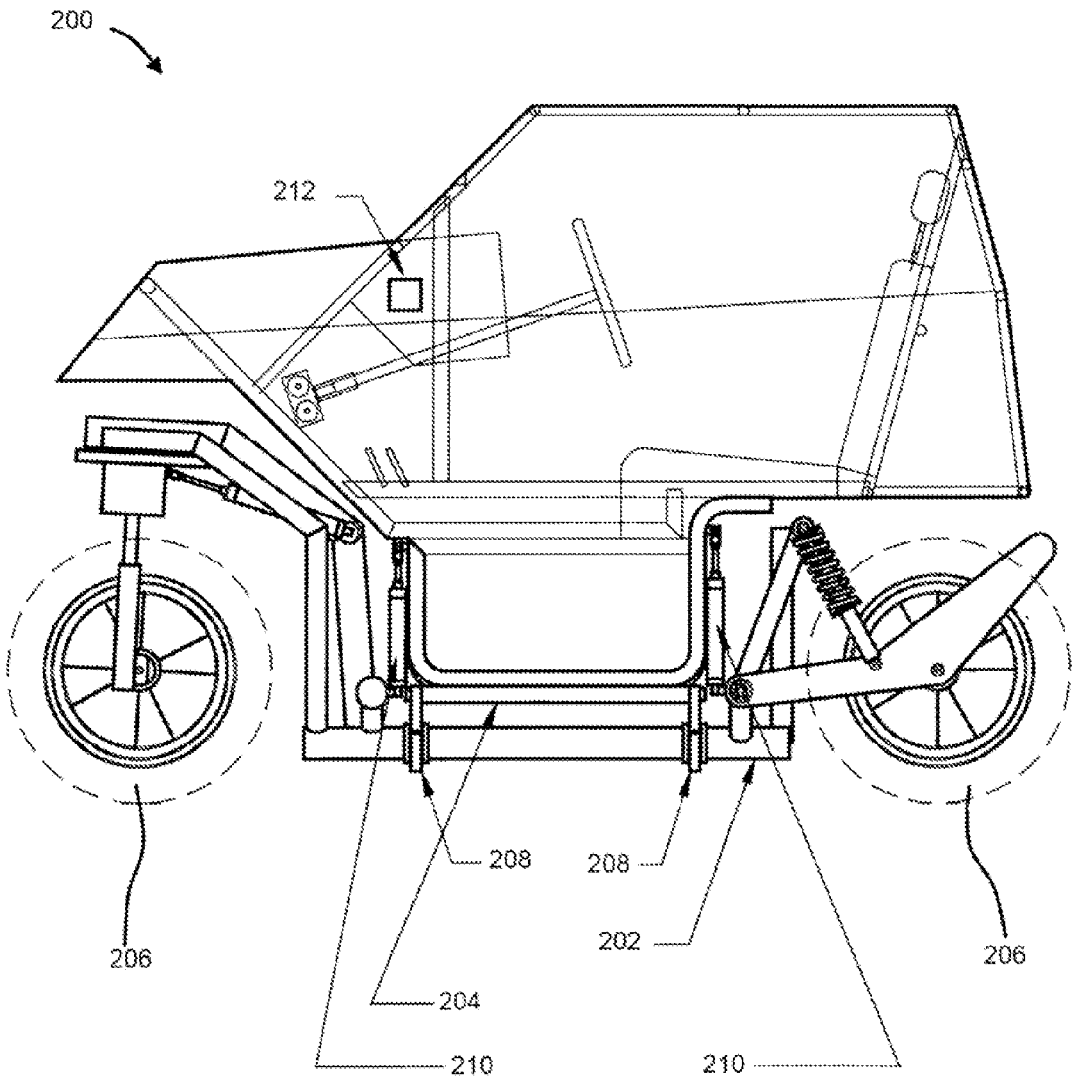

FIGURE 7

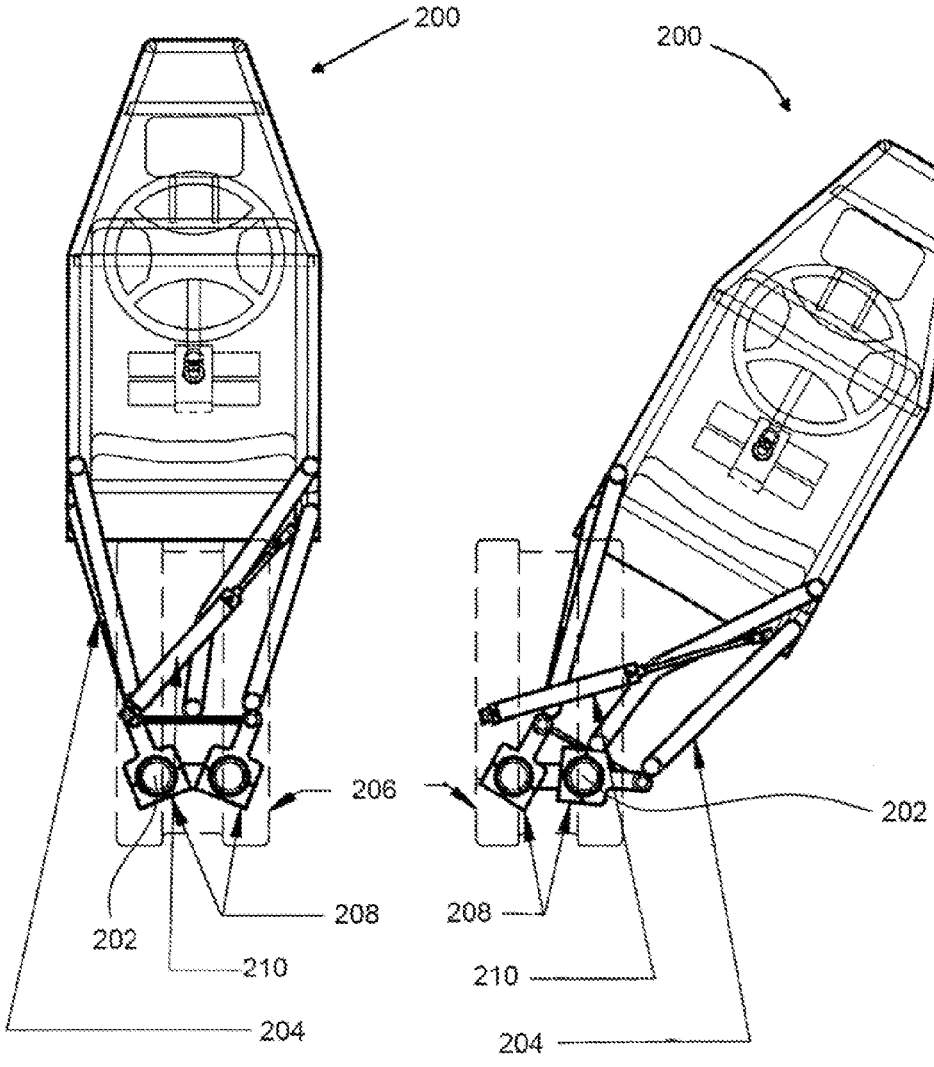

FIGURE 8A *FIGURE 8B*

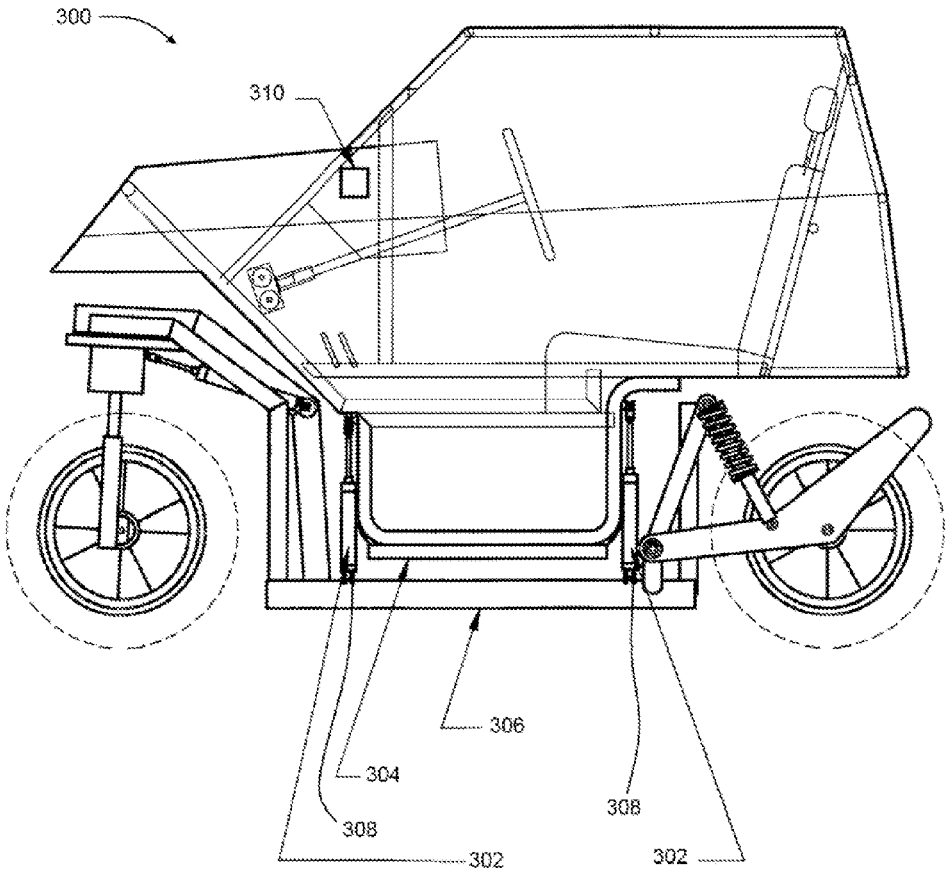

FIGURE 9

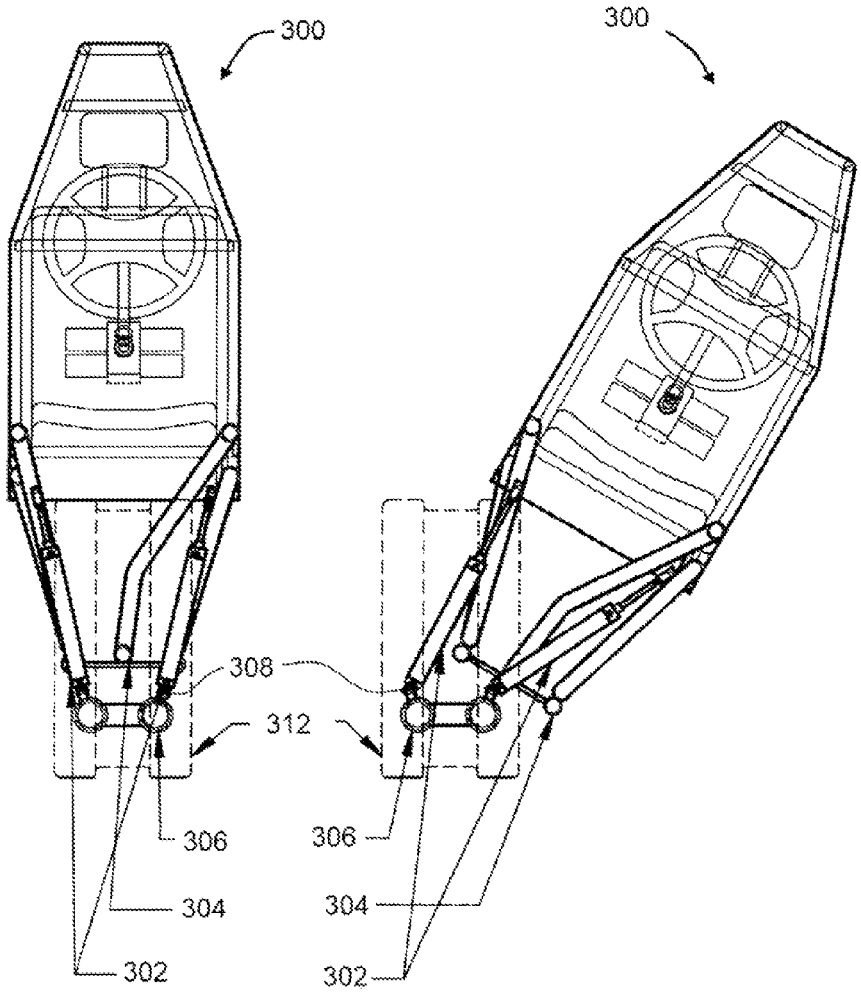

FIGURE 10A *FIGURE 10B*

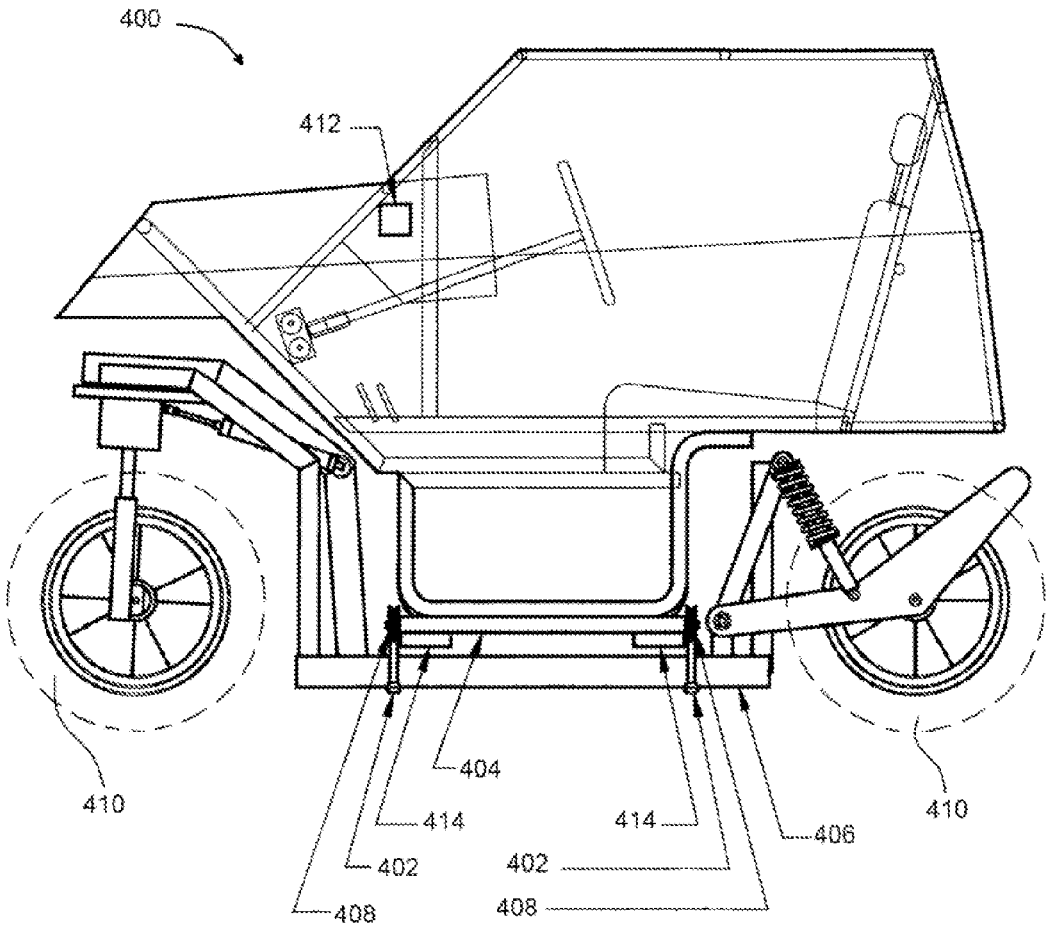

FIGURE 11

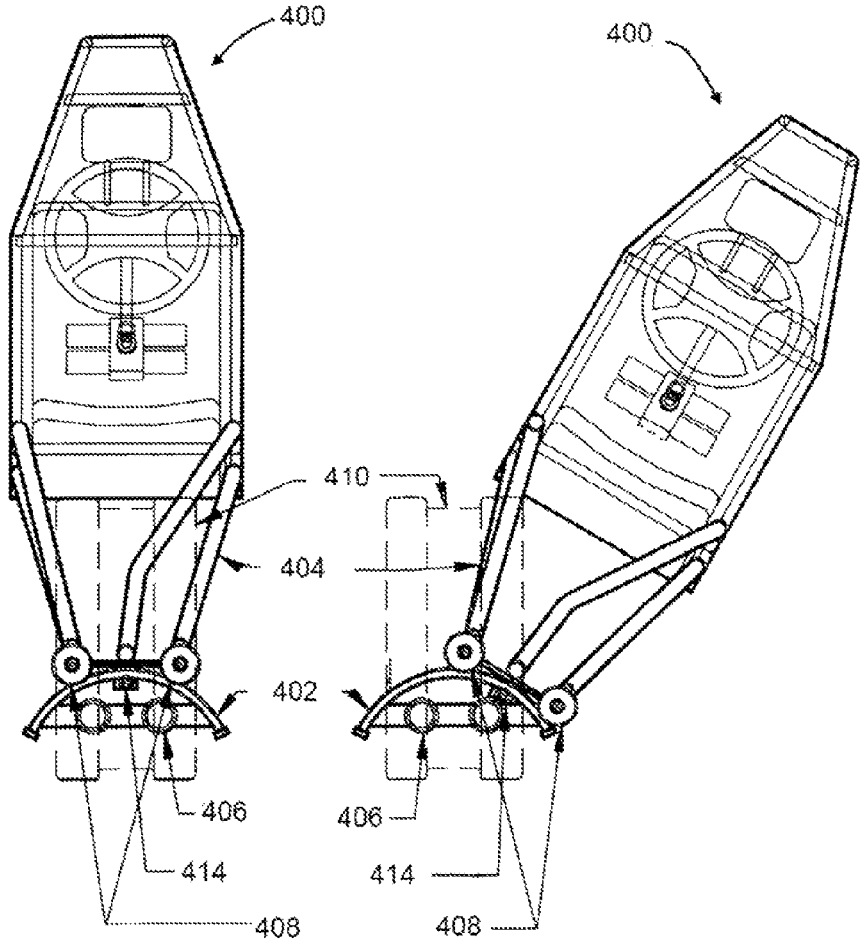

FIGURE 12A *FIGURE 12B*

LEAN-COMPENSATING MOTORCYCLE WITH CHANNEL WHEELS

This application claims the benefit of the filing date of provisional application No. 61/900,941, filed on Nov. 6, 2013.

BACKGROUND

Motorcycles and other two wheeled vehicles known in the art employ gyroscopic forces to remain upright when travelling. Consequently these vehicles require support when at a stop, such as an operator holding up the vehicle by placing one foot on the ground. In some circumstances, it may be desirable to have the vehicle remain upright when standing still without having a foot on the ground, such as in rain, or heavy traffic conditions. Another problem encountered with two wheeled vehicles is the tendency for traffic markers, such as reflectors and ceramic domes protruding from the pavement to interrupt smooth travel of the vehicle, particularly when splitting lanes.

Apparatus for adjusting or compensating for gravitational forces against a two-wheeled vehicle, such as a motorcycle, are known in the art. Horiike (U.S. Pat. No. 5,076,388) discloses a vehicle having a sub-frame connected to a main frame of a vehicle. The sub-frame is able to bank around the main frame during cornering using a counterbalancing of centripetal forces and centrifugal forces as a driver makes a turn.

Moog (U.S. Pat. No. 4,200,168) discloses an apparatus for roll-stabilizing a vehicle. A compound physical pendulum is designed to sense any lateral acceleration of a vehicle, and using a rigid dumbbell-shaped member mounted on the upper end of a flexure tube, compensate for inertia. By using gyroscopic action, the dumbbell-shaped member is able to engage the vehicle and counter any overturning movement.

Apparatus for addressing tire performance are also known in the art. Yoshioka (U.S. Pat. No. 6,499,520) discloses a pneumatic tire having a circumferentially and continuously extending wide groove to enhance steering capability. Nakagawa et al. (U.S. Pat. No. 6,505,661) discloses a tire having a tread portion including a groove having longitudinal and lateral ribs to prevent bareness. Matsunaga (U.S. Pat. No. 8,091,598) discloses a tire with multiple grooves extending circumferentially around the motorcycle tire for stability.

The stabilizing apparatus currently disclosed in the art are designed to compensate for gravitational forces while a two-wheeled vehicle is in motion rather than at a standstill. The wheels having grooves disclosed in the prior art are adapted for performance enhancing characteristics or preventing excessive wear on a tire, and none of them present a groove large enough to straddle reflectors or lane dots.

There is therefore a need for a two-wheeled vehicle stabilization device, such as for a motorcycle, that corrects for gravitational forces when the vehicle is at rest. There is also a need for a two-wheeled vehicle tire that avoids protrusions in the pavement from traffic markers and lane dots that would otherwise interrupt smooth travel of the vehicle.

SUMMARY

A lean-compensating motorcycle for balancing a user includes a lower frame connected to the wheels of the motorcycle, and an upper frame having a user support, such as a motorcycle seat. A pivot structure is coupled to the lower frame and the upper frame, and allows the lower frame and the upper frame to move relative to each other. The moving, or twisting, motion occurs on an axis substantially parallel to the motorcycle's line of travel. A pivot drive coupled to both the lower frame and the upper frame is typically powered and adjustable, and governs the pivoting movement of the lower frame and the upper frame about the pivot. The pivot drive is governed by a control system that senses, collects and manages position data regarding the upper frame, controlling the behavior of the pivot to adjust the upper frame's position relative to the lower frame. Specifically, the control system adjusts the pivot drive's position to cause the pivot drive to maintain the upper frame in a substantially vertical position by applying force against the lower frame.

The motorcycle includes wheels that are preferably as wide or wider than the lower frame to allow counterbalancing when the upper frame pivots. The wheels ideally include a central channel, which is sized to accommodate raised pavement markers, such as dots and reflectors, to provide for smooth travel when in motion, and to allow the wheels to rest flat on the pavement when not in motion. In one embodiment, the wheels might be made of two separate tires having a common hub that forms the central channel.

Preferably, the upper frame includes a housing for protecting the user. The housing may be a protective cage, or may be a more solid housing that optionally incorporates a protective cage. Due to the counterbalancing characteristics of the motorcycle, the support in the upper frame may be a recumbent, automobile-type seat in lieu of a traditional motorcycle seat. Also, the upper frame may include a steering wheel, a brake pedal and a gas pedal like a conventional automobile.

For effective pivoting, the pivot may include a pivot platform that supports the upper frame, the lower frame surrounded by the pivot in a manner similar to a race bearing. To maximize the length of travel when leaning side to side, two pivot drives may be incorporated between the upper frame and lower frame and arranged in a cross configuration.

The control system governs the position of the pivot drives, and may also include an off-level alarm. With an alarm incorporated into the control system, it is possible to allow both automatic, and manually controlled pivoting. A movable pivot arm may be coupled to the lower frame and the upper frame to help support the upper frame as the pivot drive causes it to move relative to the lower frame. The pivot arm is preferably governed by the pivot drive.

In other embodiments, a curved rail in static relation to the lower frame, and about which the upper frame travels in an arc may characterize the pivot mechanism. In such an arrangement, grooved wheels may be positioned on the curved rail and coupled to the upper frame. A drive motor may control movement of the grooved wheels along with, or in lieu of the pivot drives.

The lean compensating motorcycle may also be characterized as having a pivoting frame with a lower section and an upper section in a pivoting relationship. The lower section is coupled to a wheel or wheels of the motorcycle, while the upper section includes a housing to protect the user. The lower section and the upper section are connected by a pivot driver, and the wheels are substantially wider than the lower section, so that when the upper section pivots relative to the lower section, the lower section counterbalances itself against the wheels. A level-sensing control system causing the pivot driver to maintain the upper frame upright whenever the upper frame lists away from vertical,

and the wheels include a channel wide enough to accommodate raised highway markers for smooth travel.

To maintain an upright position when riding a two-wheeled motorcycle, a user rides the motorcycle, balancing it against gyroscopic force generated by the rotating wheels to keep the motorcycle upright. Eventually, the user must bring the motorcycle to a stop, thereby eliminating the gyroscopic force. Shortly after coming to a stop, the motorcycle begins leaning away from upright. At this point the lean-compensating mechanism begins twisting an upper section of the motorcycle relative to a lower section of the motorcycle to maintain the upper section upright.

The lower section counterbalances against the wheels to push back against the upper section. While stopped, a control system continuously monitors the upper section for any leaning movement away from substantially upright, and counters it against the lower section. When the motorcycle starts moving again, gyroscopic force is once again generated by the rotating wheels, allowing conventional balancing. It is anticipated that the lean-compensating function can function in lieu of, or in concert with conventional balancing.

BRIEF DESCRIPTION OF THE FIGURES

FIG. **1** is a side view of a lean-compensating motorcycle having a housing and channel wheels ("motorcycle").

FIGS. **2**A and **2**B are rear views, respectively, of the motorcycle in an upright position and in a leaning position.

FIG. **3** is a side view of a first alternative embodiment motorcycle.

FIG. **4** is a top view of the first alternative embodiment motorcycle without the housing.

FIGS. **5**A and **5**B are rear views, respectively of the first alternative embodiment motorcycle in an upright position and in a leaning position.

FIG. **6** is a side view of the first alternative embodiment motorcycle showing operational parts.

FIG. **7** is a side view of a second alternative embodiment lean-compensating motorcycle with channel wheels.

FIGS. **8**A and **8**B are rear views, respectively of the second alternative embodiment motorcycle in an upright position and in a leaning position.

FIG. **9** is a side view of a third alternative embodiment lean-compensating motorcycle with channel wheels.

FIGS. **10**A and **10**B are rear views, respectively of the third alternative embodiment motorcycle in an upright position and in a leaning position.

FIG. **11** is a side view of a fourth alternative embodiment lean-compensating motorcycle with channel wheels.

FIGS. **12**A and **12**B are rear views, respectively of the fourth alternative embodiment motorcycle in an upright position and in a leaning position.

REFERENCE NUMBERS

10. motorcycle
12. lower frame
14. upper frame
16. channel wheels
18. control system
20. pivot drive cylinder
22. pivot
23. platform
24. housing
26. channel
28. seat
30. steering wheel
32. dashboard
34. gas pedal
36. brake pedal
100. first alternative embodiment motorcycle
102. lower frame
104. upper frame
106. channel wheels
108. channel
110. center line
112. pivot
114. pivot drive cylinder
116. control system
118. housing
120. seat
122. steering wheel
124. dashboard
126. gas pedal
128. brake pedal
200. second alternative embodiment motorcycle
202. lower frame
204. upper frame
206. channel wheels
208. pivot
210. pivot drive cylinder
212. control system
300. third alternative embodiment motorcycle
302. pivot drive cylinder
304. upper frame
306. lower frame
308. pivot
310. control system
312. channel wheels
400. fourth alternative embodiment motorcycle
402. curved rail
404. upper frame
406. lower frame
408. grooved wheels
410. channel wheels
412. control system
414. drive motor

DESCRIPTION

Referring to FIG. **1**, a side view of a lean-compensating motorcycle, in its primary embodiment with channel wheels ("motorcycle") **10** is shown. The motorcycle **10** includes a lower frame **12**, an upper frame **14** for a rider, and channel wheels **16**. The lower frame **12** is adapted to allow the upper frame **14** to lean relative to the channel wheels **16**, allowing the lower frame **12** to counterbalance the upper frame **14** against the channel wheels **16** if the upper frame **14** begins to lean in a direction other than vertical. The channel wheels **16** may be widened to form an outrigger-type structure for effective counterbalancing support.

Still referring to FIG. **1**, when the motorcycle **10** comes to a stop and the upper frame **14** begins to list, a control system **18** senses, collects and manages position data regarding the upper frame **14**, controls the behavior of a pivot drive cylinder **20**, causing it to act on a pivot **22** coupling the lower frame **12** to the upper frame **14**. The pivot **22** is preferably a structure having a pivoting action. The control system **18** adjusts the pivot drive cylinder **20**, changing the upper frames **14** position relative to the lower frame **12** through pivoting motion in the pivot **22**. In one embodiment, the control system **18** is mounted on the upper frame **14**. As

discussed below, a variety of mechanisms for pivoting rotation are contemplated according to various embodiments.

Still referring to FIG. **1**, the pivot **22** may include a platform **23** to which the upper frame **14** is coupled, the pivot coupled to the lower frame **12**. Additionally, the motorcycle may be recumbent, allowing a user (not shown) to sit in a more conventional position.

Still referring to FIG. **1**, since the motorcycle **10** is able to remain upright at a standstill, features common to three and four-wheeled vehicles may be incorporated according to preference. In particular, the motorcycle **10** may include a housing **24**, which may function as a protective cage in the event of an accident, and may also be sufficiently enclosed to prevent moisture and wind intrusion. Since users no longer need to control lean, the housing **24** may incorporate a more conventional seat **28**, a steering wheel **30** in lieu of handles and a dashboard **32**. In such an embodiment, a conventional gas pedal **34** and brake pedal **36** may be installed in the housing **24**.

Referring to FIGS. **2**A and **2**B, the channel wheels **16** each have a channel **26** incorporated in them to provide a reduced profile, and may be constructed from a single tire having a channel **26**, or two tires with a channel between them according to design and manufacturing preference. The purpose of the channel **26** is to allow the channel wheels **16** to ride over traffic markers such as reflectors, ceramic dome-shaped indicators, and in particular to travel over such obstacles when the motorcycle **10** is in motion on a street or highway. The wide flat profile of the channel wheels **16** also allows the motorcycle **10** to balance when at a stop due to their substantially wide profile.

Referring to FIG. **2**A, the motorcycle **100** includes two pivot drive cylinders **20** arranged in a cross pattern. The top of each pivot drive cylinder **20** is coupled to the upper frame **14**. while the bottom of each pivot drive cylinder **20** is connected to the lower frame. In this embodiment the upper frame **14** and lower frame **12** are connected along a single pivot **22**. Referring to FIG. **2**B, when the motorcycle leans over, the cross pattern of the pivot drive cylinders **20** allows for a greater extension of each pivot drive cylinder, and therefore a greater total length of travel correction.

Referring to FIG. **3**, a side view of a first alternative motorcycle **100** is shown. The motorcycle **100** (and remaining embodiments thereof) includes a lower frame **102**, an upper frame **104** for a rider, and channel wheels **106**. Using the same principal of operation, the lower frame **102** allows the upper frame **104** to lean relative to the channel wheels **106**, allowing the lower frame **102** to counterbalance the upper frame **104** against the channel wheels **106** if the upper frame **104** begins to lean in a direction other than vertical. The channel wheels **106** are preferably extra wide, forming an outrigger-type structure supporting effective counterbalancing.

Referring to FIG. **4**, the motorcycle **100** is shown without the housing and with a center line **110** indicating the general line of travel of the motorcycle **100** and the axis about which the upper frame **104** (FIG. **3**) and lower frame **102** pivot. Because the centerline **110** is centered in the channel **108** of the channel wheels **106**, the channel wheels **106** provide effective resistance as the upper frame **104** turns on the pivot

Referring to figure SA the motorcycle **100** is shown in an upright position. In this position the lower frame **102** and upper frame **104** are in alignment as is customary for any conventional two wheeled vehicle. Referring to FIG. **51**, the upper frame **104** is able to lean relative to the lower frame **102**. This may be needed to maintain balance when one of the channel wheels **106** is turned, when cornering, as shown in FIG. **3**B, or may be performed when the motorcycle **100** is directed in a straight line at a standstill to compensate for the upper frame **104** leaning relative to the lower frame **102**. Preferably, the upper frame **104** is connected to a pivot drive cylinder **114**, which functions to position the upper frame **104** relative to the lower frame **102**, in some embodiments the driver may be in manual control the pivoting function.

FIG. **6** provides a more detailed view of the motorcycle **100** with the interior of the housing **118** exposed. In order to stabilize the motorcycle **100**, two pivot drive cylinders **114** are incorporated near the channel wheels **106**. In order to allow the lower frame **102** and upper frame **104** to move relative to one another, the pivots **112** connect the upper frame **104** to the lower frame **102**. In order to allow the motorcycle **100** to automatically correct for lean in the upper frame **104**, a control system **116** for maintaining level may be incorporated into the upper frame **104**. The control system **116** may not automatically engage the pivot drive cylinders **114**, but may merely alert a driver (not shown) that the upper frame **104** is beginning to lean away from vertical, and allow the driver to manually control and correct the lean as desired.

Still referring to FIG. **6**, like the primary embodiment motorcycle **10** (FIG. **1**), since the first alternative embodiment motorcycle **100** is able to remain upright at a standstill, features common to three and four-wheeled vehicles may be incorporated according to preference. In particular, the motorcycle **100** includes a housing **118**, which may function as a protective cage in the event of an accident, and may also be sufficiently enclosed to prevent moisture and wind intrusion. Since users no longer need to control lean, the housing **118** may incorporate a more conventional seat **120**, a steering wheel **122** in lieu of handles and a dashboard **124**, in which the control system **116** and an associated display (not shown) may be housed. In such an embodiment, a conventional gas pedal **126** and brake pedal **128** may be installed in the housing **118**. The housing **118** and its related features may be incorporated into any of the embodiments discussed herein.

Referring to FIG. **7**, a second alternative embodiment motorcycle **200** is shown. In the second alternative embodiment, rotating pivots **208** potentially including pivot arms (not shown) are used to connect the lower frame **202** to the upper frame **204**. In this embodiment, the channel wheels **206** are connected to the lower frame **202** and the pivots **208** are used to articulate the upper frame **204** relative to the lower frame **202** when the pivot drive cylinder **210** is active. A control system **212** is used to maintain level as with the primary embodiment either automatically or manually.

Referring to FIGS. **8**A and **8**B, a rear view of the motorcycle **200** shows the changing orientation of the pivots **208**, as they compensate for the motorcycle **200** in an upright position and when the upper frame **204** is leaning relative to the lower frame **202**. The pivot drive cylinders **210** are used to adjust the lean angle of the upper frame **204**.

Referring to FIG. **9** a third alternative embodiment motorcycle **300** is shown. In the third alternative embodiment, four pivot drive cylinders **302** are used to articulate the upper frame **304** relative to the lower frame **306**. In this embodiment, pivots **308**, which may be characterized as pivot points between the upper frame **304** and lower frame **306** allow them to move relative to each other. As with the other embodiments, a control system **310** for maintaining level may be incorporated on the upper frame **304**, allowing for automatic or manual lean control.

Referring to FIGS. **10**A and **10**B, a rear view of the motorcycle **300** shows the support cylinders **302** in operation and the position of the upper frame **304** and the lower frame **306**. Also shown in this view is the position of the channel wheels **312** relative to the upper frame **304** as it leans at an angle.

Referring to FIG. **11**, a fourth alternative embodiment motorcycle **400** is shown. In the fourth alternative embodiment, two curved rails **402** are used for articulating the upper frame **404** relative to the lower frame **406**. In one embodiment grooved wheels **408**, not to be confused with the channel wheels **410**, are positioned on the curved rail **402** for swinging the upper frame **404** from an upright to a leaning position. As with the other embodiments, a control system **412** for maintaining level may be incorporated on the upper frame **404** allowing for automatic or manual lean control. In this embodiment, the addition of drive motor **414** may be necessary to rotate the upper frame **404** relative to the lower frame **406**.

Referring to FIGS. **12**A and **12**B, a rear view of the motorcycle **400** shows the curved rail **402**, which is a substantially arced member over which grooved wheels **408** travel. The grooved wheels **408** are attached to the upper frame **404**, and may incorporate the drive motor **414** for articulating the upper frame **404** relative to the lower frame **406**.

The foregoing description of the preferred embodiment 10 of the invention is sufficient in detail to enable one skilled in the art to make and use the invention. It is understood, however, that the detail of the preferred embodiment presented is not intended to limit the scope of the invention, in as much as equivalents thereof and other modifications which come within the scope of the invention as defined by the claims will become apparent to those skilled in the art upon reading this specification.

What is claimed is:

1. A single track two-wheeled motorcycle configured for balancing a user, the motorcycle comprising:

a lower frame having the two wheels;

an upper frame having a user support;

a pivot structure coupled to the lower frame and coupled to the upper frame, the pivot structure set on an axis substantially parallel to the motorcycle's axis of travel for allowing pivoting movement of the lower frame relative to the upper frame;

a pivot drive coupled to the lower frame and coupled to the upper frame, the pivot drive controlling pivoting movement of the lower frame relative to the upper frame about the pivot structure; and

a control system causing the pivot drive to maintain the upper frame in a substantially vertical position.

2. The motorcycle of claim **1** wherein at least one of the wheels is wider than the lower frame.

3. The motorcycle of claim **1** wherein at least one of the wheels has a central channel.

4. The motorcycle of claim **3** wherein the central channel is sized to accommodate raised pavement markers.

5. The motorcycle of claim **3** wherein the central channel has a hub.

6. The motorcycle of claim **1** wherein the upper frame comprises a housing for enclosing the user.

7. The motorcycle of claim **1** wherein the upper frame comprises a protective cage surrounding the user.

8. The motorcycle of claim **1** wherein the upper frame comprises a recumbent, automobile-type seat.

9. The motorcycle of claim **1** wherein the upper frame includes a steering wheel, a brake pedal and a gas pedal.

10. The motorcycle of claim **1** further comprising a second pivot drive arranged in a cross configuration to the pivot drive.

11. The motorcycle of claim **1** wherein the control system includes an off-level alarm.

12. The motorcycle of claim **1** wherein the control system permits manually controlled pivoting.

13. The motorcycle of claim **1** further comprising a curved rail in static relation to the lower frame, and about winch the upper frame travels in an arc.

14. The motorcycle of claim **13** wherein grooved wheels are positioned on the curved rail and coupled to the upper frame.

15. The motorcycle of claim **14**, further comprising a drive motor that controls movement of the grooved wheels.

16. A lean compensating single tracked two-wheeled motorcycle for balancing a user, comprising:

a pivoting frame having a lower section and an upper section in a pivoting relationship about an axis substantially parallel to the motorcycle's axis of travel;

the lower section coupled to the two wheels of the motorcycle;

the upper section having a housing for protecting the user;

the lower section and the upper section connected by a pivot driver;

wherein at least one of the two wheels is substantially wider than the lower section, so that when the upper section pivots relative to the lower section, the lower section counterbalances itself against at least one of the two wheels; and

a level-sensing control system causing the pivot driver to maintain the upper frame upright whenever the upper frames lists away from vertical.

17. The motorcycle of claim **16**, wherein at least one of the two wheels comprises a channel wide enough to accommodate a raised highway marker.

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